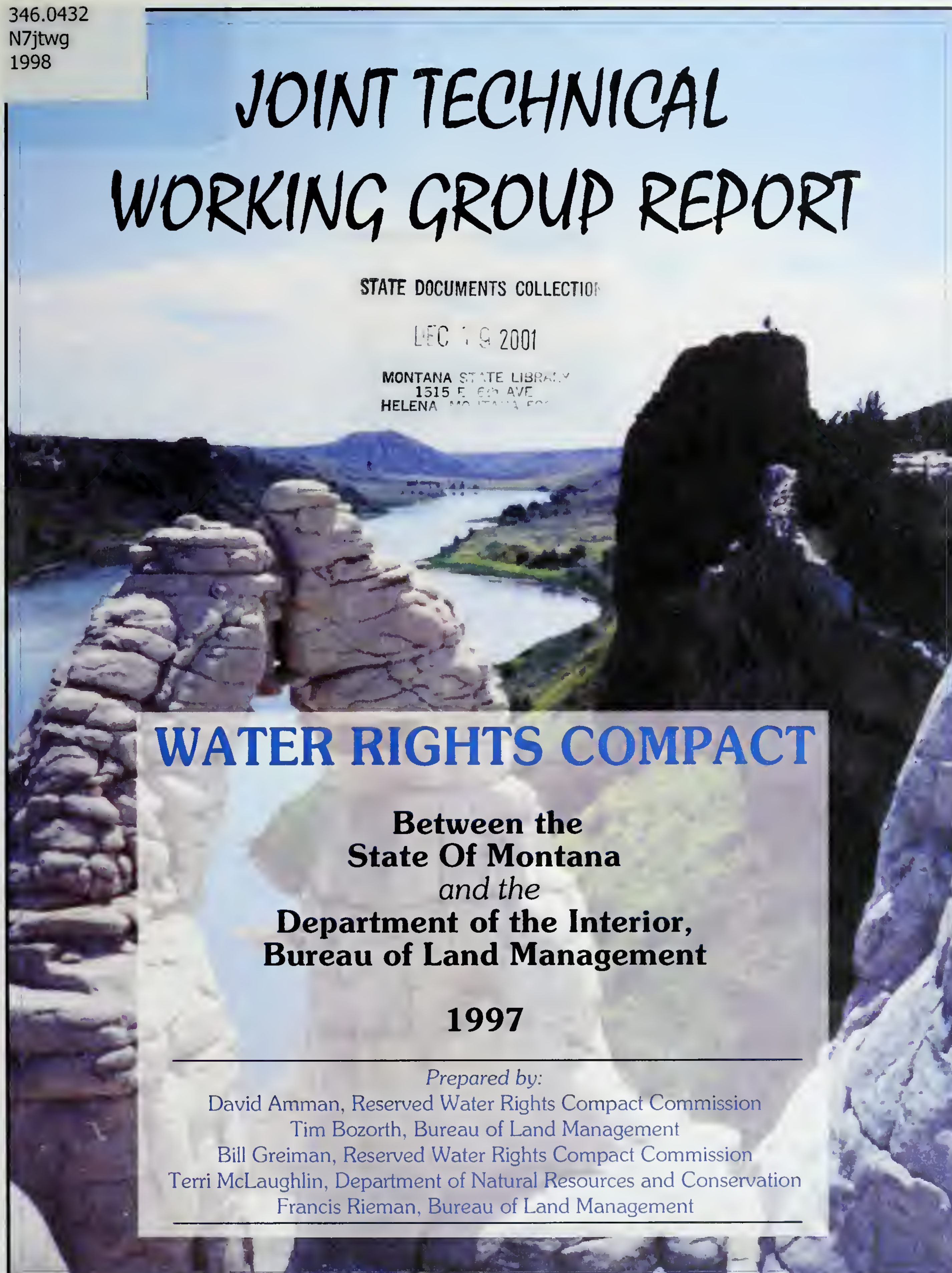

JOINT TECHNICAL WORKING GROUP REPORT

WATER RIGHTS COMPACT

Between the
State Of Montana
and the
Department of the Interior,
Bureau of Land Management

1997

Prepared by:
David Amman, Reserved Water Rights Compact Commission
Tim Bozorth, Bureau of Land Management
Bill Greiman, Reserved Water Rights Compact Commission
Terri McLaughlin, Department of Natural Resources and Conservation
Francis Rieman, Bureau of Land Management

JOINT TECHNICAL WORKING GROUP REPORT

WATER RIGHTS COMPACT

BETWEEN THE

STATE OF MONTANA

AND THE

DEPARTMENT OF THE INTERIOR, BUREAU OF LAND MANAGEMENT

1997

PREPARED BY:

David Amman, Reserved Water Rights Compact Commission
Tim Bozorth, Bureau of Land Management
Bill Greiman, Reserved Water Rights Compact Commission
Terri McLaughlin, Department of Natural Resources and Conservation
Francis Rieman, Bureau of Land Management

November, 1998

JOINT TECHNICAL WORKING GROUP REPORT

JOINT TECHNICAL WORKING GROUP REPORT

OVERVIEW AND BACKGROUND

This report provides background and documentation of the technical methodologies and assumptions used in settling the reserved water rights claimed by the Bureau of Land Management (BLM) for the Upper Missouri National Wild and Scenic River (UMNW&SR). The technical work was completed by staff of the Montana Reserved Water Rights Compact Commission (RWRCC), Montana Department of Natural Resources and Conservation (DNRC), U.S. Bureau of Land Management (BLM) and U.S. Bureau of Reclamation (BOR).

In 1984, the BLM submitted to the RWRCC a technical report which quantified instream flow requirements of various elements for which they believed the UMNW&SR to be reserved (USBLM 1984). The report included flow requirements for side channels and riffles for fish spawning and rearing; safe passage of recreational floating vessels; protection of islands from predators of nesting geese; channel maintenance; and upstream migration of spawning paddlefish. These claims were later amended to include high flows for cottonwood regeneration and adjustments were made to the channel maintenance flows.

When negotiations resumed in 1992, the RWRCC and Federal team had opposing legal interpretations of the legislative act which reserved the UMNW&SR and could not agree on the primary purposes of the reservation. Consequently, the 1984 report was not accepted as a definitive analysis of flows required for the reservation, and the negotiators sought an alternative approach.

Instead of attempting to determine the natural attributes and corresponding water needs of the UMNW&SR, the negotiators agreed to determine a reasonable amount of water for additional State future use in the basin, leaving the remaining river flow as the BLM reserved right. Two technical teams were created to assemble information, analyze data, and recommend processes which would make implementation of the Compact practical.

The first team, the DNRC Working Group, was composed of representatives from bureaus within DNRC. This team was directed to determine a reasonable amount of future consumptive water use in the Missouri River Basin above Fred Robinson Bridge.

The second team, the Joint Technical Working Group (JTWG), was composed of technical personnel from state and federal agencies, including RWRCC, DNRC,

BLM and BOR. The duties of this team were to quantify the amount of water needed to supply future state water uses, create a methodology for calculating depletions from future uses of water, including surface, stored and ground water, and to analyze the effects of future depletions on existing streamflows within the UMNW&SR.

RIVER MODEL

The Upper Missouri HYDROSS (Hydrologic Operations Study) computer model was developed by the BOR to evaluate surface water supply in the Missouri River basin above Fort Peck Lake. The model was used by the JTWG to examine the effects of increased irrigated acreage in the basin on streamflows within the UMNW&SR.

The model includes simulations of flows on major tributaries and the Missouri River mainstem, and correlates irrigated acres to gaged streamflows for the period 1928 through 1987. Therefore, the model simulates the effects of existing or proposed development on historic naturalized streamflows.

HYDROSS can be used to perform theoretical future development scenarios in the basin, such as increased irrigated acreage or additional water storage. The model calculates average monthly flows for wet, average and dry water years, for any particular development scenario.

Since the model compares streamflows to irrigated acres, it does not take into account water rights which are legally valid, but were not in use during the period 1928 through 1987. Examples of such rights are the state water reservations that were granted by Final Order of the Board of Natural Resources on June 30, 1992. These water reservations for consumptive uses are not yet developed, but possess a 1985 priority date. Conversely, late-claim water rights were in use and their depletions were implicit in the model results.

The model reflects historic consumptive use through December 31, 1987. Instead of revising the model and extending it into the 1990s, depletions from water developments occurring after this date were calculated using the methods created by the JTWG and described in the compact.

A full description of the Upper Missouri model is included here as Attachment 1. The actual HYDROSS model and information used to develop the model are archived in the Montana State Library.

DNRC WORKING GROUP

A team of DNRC experts was assembled to calculate future consumptive water needs in the Upper Missouri River basin (MDNRC 1996). The report is included here as Attachment 2. Data assembled during the Montana Upper Missouri River Basin Water Reservations process were used to estimate economically feasible irrigable acreage in the basin (DNRC 1991). Based on soils, economics and other factors, the state water reservation studies identified approximately 100,000 acres (98,826 acres) which are currently not developed, but could be productive in the future.

Future municipal and industrial uses were also part of the state water reservations process. Several municipalities submitted reservation requests for additional water to supply increasing demands due to population and industrial growth. The reservations granted in the Board's Final Order were used by the Working Group to estimate future additional municipal and industrial needs to the year 2025 (MBNRC 1992). This amounted to 24,000 acre feet per year.

At this point, the technical groups had sound estimates of future additional agricultural development (100,000 acres), and future increased municipal and industrial demands (24,000 acre feet per year) in the Upper Missouri River Basin. The next tasks were to determine the depletions occurring from agricultural development, and insure that the amount of water set aside for future use was adequate.

JOINT TECHNICAL WORKING GROUP

The Joint Technical Working Group (JTWG) was composed of staff from the RWRCC, DNRC Water Management and Water Rights Bureaus, the BLM and the BOR. The JTWG was assembled to determine the amount of water needed to irrigate the projected 100,000 acres of additional acreage, recommend methods of calculating depletions from water use permits, determine the effects of future storage on streamflows, and recommend an accounting process for depletions occurring from groundwater withdrawals. The JTWG was also to recommend how any agreement would be administered without significant expense or additional work for DNRC.

AVAILABLE WATER SUPPLY

The amount of water set aside for future State uses was eventually called the Available Water Supply (AWS). The AWS is the allowable amount of additional

depletion in the upper basin, by month, beyond existing depletions (i.e., as of December 31, 1987). There is no minimum flow level at which the BLM may call users to stop using water, and the BLM cannot object to new permits within the volume amounts listed in the AWS.

The AWS was debated and altered several times to address concerns from both the State and BLM. The State argued that there should be enough water to satisfy irrigation demands of the 100,000 acres from direct flow, future storage (except on the mainstem of the Missouri River) and increased future municipal needs. The BLM was concerned that during dry years, the additional demands could deplete the river below historic low flows.

The JTWG began by calculating the difference between the 1984 BLM request (averaged by month) and the 1987 level of development median year (50% exceedence) monthly flows, as calculated by the HYDROSS model. This allowed very large depletion volumes during winter, which is a time of low water use. Therefore, the AWS was adjusted down for August through March by calculating the difference between the 1984 BLM request and the HYDROSS 75% exceedence flows.

The BLM then raised concerns that this version of the AWS would allow the river to drop below historic low flow levels during July and August of the 90% exceedence flow year. The BLM and other agencies felt that the river should not be intentionally depleted lower than 4000 cfs. Therefore, the AWS was lowered for July and August so that flows of 4000 cfs would remain instream during the 90% exceedence year. In exchange, the AWS was raised for September to allow depletion down to an instream flow of 4000 cfs during the 90% exceedence year.

The prospect of very low winter flows was a concern for the BLM. Low winter flows can severely impact resident fisheries because side channels, which are rearing areas for young fish, can dry out or freeze solid. Therefore, the AWS was reduced by 350 cfs for November through February.

Since the model outputs were based on the 1987 level of development, depletions from water uses occurring between 1988 and 1995 were also to be subtracted out of the AWS. Depletions from these uses were calculated using methods described in the compact. These depletions were then added back in to the AWS, to be removed after ratification of the compact. The monthly AWS figures were then rounded to the nearest 1000 acre feet.

At the final Negotiating Session between the State and BLM, the AWS numbers were changed somewhat. The parties had not reached agreement on how federal and Indian reserved water rights, as yet unquantified, would affect the AWS. BLM

was concerned with the impact to instream flow from development of unidentified, unquantified reserved water rights. To accommodate some level of future development outside of the State system, the AWS was lowered in April, May and June to numbers proposed by BLM based on their internal review. The AWS was also lowered in July and August to numbers suggested by the State to reflect water sufficient to meet future State needs instead of the historic low flow of 4000 cfs during the 90% exceedence year. Federal and tribal water rights will not be subtracted from the AWS. These were the last adjustments to the AWS.

The JTWG calculated an AWS that would satisfy post-1987 permits, provide water for about 100,000 acres of additional irrigated land and additional municipal needs, provide for the possibility of future non-mainstem storage (approximately 500,00 acre-feet), and not deplete the river below historic low flow levels.

The following table lists the AWS volumes from which future consumptive appropriations, beginning with those having priority dates of January 1, 1988, will be subtracted.

	Acre feet
January	104,000
February	121,000
March	124,000
April	185,000
May	219,000
June	62,000
July	82,000
August	66,000
September	40,000
October	35,000
November	57,000
December	98,000

CALCULATION OF DEPLETIONS

The JTWG produced a report recommending a methodology for calculating monthly depletions of various water uses (JTWG 1996). The report is included here as Attachment 3. The Compact specifies that in the future when the calculated depletions for a particular month equal the AWS for that month, the Missouri River basin above Fred Robinson Bridge (the downstream extent of the Missouri Wild and Scenic River) will close to additional consumptive appropriations for that month. Mont. Code Ann. § 85-20-501.

In developing depletion factors for different types of water use, the JTWG first eliminated non-consumptive water uses and other small uses, some of which are exempted by Montana statute. Such uses include instream flows for fisheries; domestic water use of 35 gallons per minute or less (surface or groundwater), up to 10 acre feet per year; permits for supplemental water; lawn and garden irrigation of five acres or less; and instream stock uses. Valid late claims are reflected in the HYDROSS model as existing development and federal and tribal water rights created under federal law are not subject to the State's regular permitting process and will not be subtracted from the AWS.

Consumptive water uses were placed into three categories based on the water source: surface water, groundwater and stored water. Depletion factors were developed for the various types of consumptive water uses, which were grouped by use codes currently employed by DNRC. The groups include ponds for fish, wildlife, stock and recreation; domestic and municipal uses; irrigation, including lawn and garden tracts greater than five acres; commercial, industrial, institutional and mining uses. Depletions are then calculated according to the source of the water and for the type of water use, and subtracted from the AWS.

SURFACE WATER

Monthly depletions for surface water uses are calculated and subtracted from the AWS in the month during which the use occurs. The depletion factors used in these calculations are listed in Appendix 1 of the Compact. Descriptions of the derivation of these factors for each category of water use subtracted from the AWS are presented below.

FISHERY, WILDLIFE, RECREATIONAL, AND WILDLIFE/WATERFOWL USES

FS Fisheries
FW Fish and Wildlife
RC Recreation
WW Wildlife/Waterfowl

Water use permit applications for fish, wildlife and recreation ponds have become quite common. Depletions from ponds occur primarily from evaporation. Evaporation factors used in the HYDROSS model were also used here to estimate these losses. The factors are based on monthly lake evaporation at Canyon Ferry Reservoir, which is located at approximately mid-basin.

The factors are listed by month, in feet per acre of pond surface area in Appendix 1 of the Compact. To calculate monthly evaporative loss in acre feet, the pond surface area (acres) is multiplied by the monthly evaporation factors.

GEOTHERMAL AND POWER GENERATION USES

GE Geothermal
PG Power Generation.

Applications for geothermal and power generation uses are rare and, because of the wide variety of possible consumptive water use needs, depletion factors for these types of water uses can not be reliably estimated. The JTWG recommended that depletions from water rights granted for these uses be determined on a case-by-case basis.

DOMESTIC, MULTIPLE DOMESTIC, AND MUNICIPAL USES

DM Domestic
MD Multiple Domestic
MC Municipal

Domestic, multi-family domestic, and municipal uses typically return a large percentage of their diverted amount in the same month that the use occurs. A reasonable estimate of depletion occurring from domestic or municipal uses is 40 to 50 percent of the diverted amount. Depletion factors for these uses were also taken from the HYDROSS model, and reflect an overall depletion of 45 percent of the annual volume of use.

The monthly factors are listed in Appendix 1 of the Compact. The factors vary by month because depletions associated with domestic water use are greater in summer months due to lawn watering and other outdoor uses of domestic water.

IRRIGATION

IR Irrigation
LG Lawn and Garden

It has been estimated that over 95 percent of all water consumed in Montana is used for agricultural purposes (USGS, 1991). The upper Missouri River basin covers approximately 41,000 square miles. Climate, soils and local water

supplies, which influence irrigation practices, vary greatly throughout the basin. This variability complicates estimates of water consumption by future irrigation. In order to keep the forecast of future agriculture reasonable, the JTWG operated under several assumptions while calculating depletions from the irrigation of additional acreage. The idea was to derive a set of variables that represent "average conditions" within the basin. Return flow characteristics, crop type and irrigation practices are examples of variables that were generalized to reflect future irrigation.

To estimate net water depletion from future irrigation, net irrigation requirements for alfalfa were first calculated using weather data at the Great Falls station. Since crop types fluctuate over time, the relatively water consumptive crop alfalfa was used in order to err on the high side of depletions, which would be in favor of river flows. Great Falls weather data was used because the station is located at approximately mid-basin.

Net depletion was then calculated from the net irrigation requirements by using a depletion efficiency of 80%. This figure assumes that there are some irrecoverable losses to deep groundwater and that return flows from sprinkler irrigation are low.

This method is not dependent on the type of irrigation used. It was assumed that future projects will be irrigated by sprinkler systems. The trend points toward sprinkler irrigation because it is far more efficient than other methods. That is, for a given acreage, the diversion amount is less for sprinklers than for other methods because the conveyance and application losses are lower.

These variables were written into a spreadsheet computer program which calculated the monthly depletion factors to be used in calculating depletions from future irrigation permits. The factors are listed in feet per irrigated acre in Appendix 1 of the Compact. When a permit is issued, the irrigated acres will be multiplied by the monthly depletion factor to calculate monthly depletions. Factors were derived only for months during which irrigation typically occurs: May through September.

STOCK USES

ST Stock

Depletions from stock ponds occur through evaporation. The depletion factors developed for pond evaporation for Fisheries, Wildlife, Recreational, and Wildlife/Waterfowl Uses will be applied in the same manner for stock ponds.

COMMERCIAL, INDUSTRIAL, INSTITUTIONAL, MINING, AND OTHER PURPOSES

CM Commercial
IN Industrial
IS Institutional
MN Mining
OP Other Purpose

This group encompasses a broad range of uses and corresponding depletion rates. These uses can range from almost non-consumptive to almost completely consumptive. Rather than attempt to define depletion factors for such a broad category, the JTWG recommended that depletions be calculated by assuming a 50 percent depletion to be spread in equal increments over the period of use of the permit until the permit development is completed and actual depletion factors can be calculated. The logic was that since these types of uses are not common, they account for very little impact to the surface water supply. The 50 percent depletion factor represents an average depletion rate for this group. That is, some uses will have greater depletions than 50 percent, some will have less. The impacts are spread equally over the period of use because of the same variability in uses.

A process was also created whereby the DNRC and BLM may discuss the monthly depletions for specific permits. DNRC will alter depletions to more accurately reflect actual depletions when sufficient information is available. To calculate depletions for each month then, the annual volume of a permit is multiplied by 50 percent, and divided by the number of months over which the water is used (e.g., divided by 12 for a year-round permit).

TRANSBASIN DIVERSIONS

Transbasin diversions remove water from one basin and transport water into another basin. It was assumed that any such diversion would be via pipeline, therefore the resulting depletion rate would be 100%, to be spread out over the period of use of the permit.

GROUNDWATER

Annual depletions from groundwater withdrawals are calculated using the methods for each type of water use described above. However, the monthly distribution of the annual depletion is different to account for the location of the diversions and

their effect on surface water flow. The effect on surface water varies greatly depending on the diversion location. For instance, a diversion located in a river floodplain may have an immediate depletion effect on surface flows. Depletions occurring from wells drawing from deeper aquifers may not show up for months or years, if ever.

Further complicating the calculation of groundwater withdrawals is the calculation of return flows. These calculations are based on basin geology and aquifer characteristics. The JTWG initially considered developing different monthly return flow coefficients for each sub-basin. However, the JTWG eventually agreed that in addition to severely complicating administration of the compact, the calculations would still be unreliable.

The JTWG weighed these factors and the uncertainty of the magnitude of future groundwater use, and recommended a uniform monthly depletion schedule, distributed evenly for each month of the year. In effect, the annual depletion will always be divided by 12 to calculate the monthly depletions for groundwater uses. For example, if the calculated annual depletion for an irrigation project is 1200 acre feet, the depletion for any month would be 100 acre feet (1200 acre feet divided by 12 months).

STORED WATER

For depletions due to future storage projects, the JTWG needed to develop a schedule that accounted for both reduction in flows due to the filling of reservoirs and depletions from the river system due to consumptive use of the stored water. The JTWG developed a depletion schedule based on average fill regimes of several smaller reservoirs in the basin. Included in the analysis were Middle Creek, Smith River, Swift, Martinsdale, Willow Creek and Ruby Reservoirs.

The rationale was that storage itself is not a depletion from the system (except for evaporative losses), but is a redistribution of river flows. Depletions come from the actual use of the water and are determined by first calculating the annual depletion based on the use for which the water is stored, then distributing it by month according to the reservoir depletion schedule. The depletion schedule is based on the average fill schedule of the five reservoirs, over the period 1961-

1990. The depletion schedule reflects the average percentage of storage that occurs by month during the storage season, November through June, as follows:

November	7%
December	8%
January	7%
February	7%
March	10%
April	21%
May	38%
June	2%

To determine the monthly depletion volumes, the annual depletion of the use for which the water is stored is multiplied by the above percentages. Additionally, evaporative losses from future storage projects must also be calculated by multiplying reservoir surface area by the monthly evaporation coefficients listed previously.

For example: a new reservoir is built to provide irrigation water. The reservoir has a surface area of 50 acres, and the annual depletion for the irrigation project is 5000 acre feet, calculated by using the irrigation factors listed earlier. The resulting monthly depletion distribution would be:

	Irrigation Depletion (acre feet)			Evaporation Depletion (acre feet)			Total
January	(7% X 5000) =	350	+	=	0	=	350
February	(7% X 5000) =	350	+	=	0	=	350
March	(10% X 5000) =	500	+	=	0	=	500
April	(21% X 5000) =	1050	+	(.08 X 50) =	4	=	1054
May	(38% X 5000) =	1900	+	(.17 X 50) =	8.5	=	1908.5
June	(2% X 5000) =	100	+	(.26 X 50) =	13	=	113
July	=	0	+	(.50 X 50) =	25	=	25
August	=	0	+	(.51 X 50) =	25.5	=	25.5
September	=	0	+	(.35 X 50) =	17.5	=	17.5
October	=	0	+	(.26 X 50) =	13	=	13
November	(7% X 5000) =	350	+	(.04 X 50) =	2	=	352
December	(8% X 5000) =	400	+	=	0	=	400
Totals		5000	+		106.5	=	**5106.5**

EFFECTS ON RIVER FLOWS

The compact allows for a considerable amount of additional depletion from the Missouri River system. However, given that some adjudication basins are permanently closed and most others are temporarily closed, full development of the AWS is doubtful. Water shortages on tributaries and large existing water rights on the mainstem Missouri River limit new development.

The following table illustrates full development, and therefore a worst-case scenario, with regard to Missouri River flows near Fred Robinson Bridge. Listed are the AWS in cubic feet per second (cfs), and the median monthly flows remaining instream after subtracting out the AWS during an average year (50% exceedence), a dry year (75% exceedence), and a very dry year (90% exceedence). For comparison, the median monthly flows (50% exceedence) for the years 1934 through 1995 and the historic monthly average low flow, both in cfs, are also listed.

	AWS (cfs)	Remaining Instream **50% Exceedence** (cfs)	Remaining Instream **75% Exceedence** (cfs)	Remaining Instream **90% Exceedence** (cfs)
January	1692	5899	5063	4150
February	2179	6202	5033	4380
March	2017	6899	6026	3991
April	3110	7390	5094	4061
May	3491	11021	7786	4344
June	943	15616	10943	7706
July	1202	9639	6009	4206
August	958	7088	5781	4336
September	609	6331	5273	4109
October	569	6186	5463	5041
November	958	6514	5570	4958
December	1594	6039	5049	4374

	Median Monthly Flows (cfs)	Historic Monthly Low Flow (cfs)
January	6649	2805 (1937)
February	7075	674 (1934)
March	8662	4884 (1937)
April	9759	4338 (1961)
May	14750	4860 (1992)
June	19930	4939 (1977)
July	10850	3956 (1940)
August	6617	2075 (1934)
September	6239	2501 (1934)
October	6593	3270 (1935)
November	6833	3581 (1938)
December	6700	3121 (1937)

Theoretically, even upon full development of the AWS, the river should not fall below historic minimum average monthly flows as a result of the additional depletions.

ADMINISTRATION

The DNRC Water Rights Bureau is currently encoding a computer accounting system to track permits, perform preliminary calculations of depletions and monitor the AWS. When the DNRC grants a permit, the type of use and other pertinent information will be entered into the system. Information currently required from applicants is adequate for administration of the compact. The depletions will be calculated and eventually finalized upon completion and verification of the permit. When depletions equal the AWS for any month, the basin above Fred Robinson Bridge will be closed to further appropriations during that month, except for those uses not subtracted from the AWS.

Each year, the DNRC will produce a report which summarizes permit activity, estimates depletions and tracks AWS levels. The compact authorizes an annual meeting between the DNRC and BLM to discuss the report, and any other issues pertaining to administration of the AWS and compact, such as calculation of depletions for undefined uses.

REFERENCES

Joint Technical Working Group: Montana Department of Natural Resources and Conservation / Reserved Water Rights Compact Commission / Bureau of Land Management. 1996. Technical Addendum to Montana and Federal Negotiating Teams.

Montana Board of Natural Resources and Conservation. 1992. Final Order Establishing Water Reservations in the Missouri Basin Above Fort Peck Dam. Montana Department of Natural Resources and Conservation, Helena, Montana.

Montana Department of Natural Resources and Conservation. 1991. Draft Environmental Impact Statement for Water Reservation Applications Above Fort Peck Dam. Helena, Montana.

Montana Department of Natural Resources and Conservation / Reserved Water Rights Compact Commission Working Group. 1994. Initial Report On Future Development in the Upper Missouri River Basin. June 10, 1994.

United States Bureau of Land Management. 1984. Instream Flow Requirements for the Wild and Scenic Missouri River. Montana State Office. Billings, Montana.

United States Geological Survey. 1991. National Water Summary 1988-89--Floods and Droughts: Montana. Water Supply Paper 2375, pp. 369-376. Helena, Montana.

ATTACHMENT 1

UPPER MISSOURI RIVER WATER AVAILABILITY STUDY
HYDROLOGY MODEL DEVELOPMENT
10/15/1992

Introduction:

The Bureau of Reclamation (Reclamation), along with the Montana Department of Natural Resources and Conservation (MTDNRC) and the Montana Power Company (MPC), is working on a study to evaluate the water availability in the Missouri River Basin above Fort Peck Reservoir. The purpose is to determine if any water is available for future development within the basin. It is necessary to determine if any new irrigation or other water use will have an adverse impact on senior water right holders, land use, reservoir operations, water quality or others.

In order to accomplish this type of study, it is necessary to define the study requirements and develop all of the necessary data which reflect the actual operations within the boundaries of the study. Necessary parameters include: a representative period of record, selections of appropriate drainage basins and the delineations of those basins, county and node basins, irrigated acreage, crop distribution patterns, return flow distribution patterns, crop consumptive use, irrigation practice information, municipal and industrial uses, soils information, reservoir operations and historical streamflows among others.

The hydrologic data base will be assembled in the form of a computer model. This model will be used to determine what level of streamflows could be expected if a 1987 level of development occurred over the period of record. The 1987 level of development will serve as the baseline for conditions in the river system.

Period of Record

The period of record selected for this study was 1928 through 1987. This period was selected primarily to include the drought of the 1930's so if a similar period returned, it would be possible to evaluate the impacts of present development on that hydrologic period.

Selection of Drainage Basins

The MTDNRC, as part of their water reservation analysis, has selected drainage basins within the area of study. Many of the drainage basins are at the mouth of major rivers and tributaries, with some delineated into smaller subareas. In all, a total of 31 nodes or sub-basins were used by the MTDNRC for analysis. Reclamation has added 6 node basins to the original 31 as the result of a meeting with study cooperators. A map and list of node basins used in the current hydrology model is enclosed.

County Irrigated Acres

One of the most important parts in this analysis was the determination of the historical irrigated acreage for each node basin. Irrigated acres are reported by county rather than drainage basin, therefore it was necessary to separate the county data into node basin data. During 1978 through 1982, Reclamation, working with the Missouri Basin States Association on a Missouri River Hydrology Study, delineated drainage areas for many basins within the Missouri River. This study determined what portion of each county was situated within each drainage basin and the number of irrigated acres each county contributed to each drainage basin within the county boundaries. This data was evaluated for 1 year, 1978.

The primary source of data for irrigated acres was the U.S. Agricultural Census. This data is prepared every 4-5 years, and records were found for the period 1919 through 1987. Irrigated acreage data for years between census records was determined by straight line interpolation.

The State of Montana has prepared two water use studies which determine irrigated acres. One was done in 1975 and the other in 1980. Based upon discussion with the MTDNRC it was decided to incorporate the results of the 1975 evaluation into the current analysis. A comparison of the U.S. Ag Census data and the 1975 water use study revealed differences between the two sets of data. In order to define a uniform data set, it was decided to use the 1975 Montana data base and prorate the U.S. Ag Census data for the period 1929 through 1975 by using a ratio of the two data sets. This provided a set of county irrigated acres for the period 1929 through 1975 agreeable to both the MTDNRC and Reclamation.

In the 1987 update, Reclamation received 1987 preliminary county acres for the Upper Missouri Basin in Montana from the U.S. Ag Census. Using this data, Reclamation requested the U.S. Soil Conservation Service (SCS) to field check the data and provide concurrence of the 1987 data. In most cases, the data were different and at different ratios than the values used in the 1975 analysis. It was decided to maintain the 1929 through 1975 data base and modify the 1976 through 1987 period to reflect the new data received in the 1987 update. Once again, a ratio between the SCS data and the U.S. Ag Census data was determined. The U.S. Ag Census data was modified by taking the yearly acres multiplied by a value determined by a straight-line interpolation between the 1987 ratio and the 1975 ratio. This provided a data set compatible with the MTDNRC water use inventory and the 1987 SCS data.

As previously mentioned, the SCS provided a breakdown of what portion of the county's irrigated lands was located in the respective node basins. Although this data was prepared in 1978, it was the best information available. Thus, these percentages were used to determine how many acres were irrigated in each node basin. A computer program was written to disseminate and accumulate the county data into node basins within the study area.

Crop Distribution Patterns

The U.S. Soil Conservation Service was requested to provide information concerning the types of crop grown within each node basin. While disseminating the county irrigated acres to the respective node basins, they were also asked to provide the acreage of each crop within each node basin. Since a node basin may lie within several county boundaries, it was necessary to calculate a weighted crop distribution pattern. This was accomplished by

summing all similar crops acres from each county within the node basin and calculating a percentage of each crop to the total crop acreage in the node basin.

Crop Consumptive Use

A computer program, CONUSE3, was used to calculate crop consumptive use. This program has the capability to calculate crop consumptive use using Jensen-Haise or Blaney-Criddle methodology, diversion requirements, return flow requirements and depletion requirements on an annual basis for the period of record. This program was initially developed for use in the MBSA Hydrology Study and has been modified recently to reflect changes in technology and needed use.

In order to initiate the calculation of consumptive use, it is necessary to select a representative climatological station within each node basin. After the station was selected, average monthly temperature, total monthly precipitation, and solar radiation data was needed at each location for the period 1929 through 1987 as input to the CONUSE3 program. In several basins, a complete record was not available. In these cases, the monthly average for the particular climate zone was used to fill in the missing record. These stations were selected generally near the middle of the drainage basin to promote average conditions. More than one climatic stations were used for several of the larger node basins. The climatic station used for each node basin is enclosed.

In this analysis, the Jensen-Haise computer program for estimating crop consumptive use was used. The Jensen-Haise methodology requires the use of solar radiation data as an input requirement. Since solar radiation real time data is not readily available in the Upper Missouri Basin, an equation to calculate solar radiation using percent of possible sunshine data was used. National Weather Service first order stations collect monthly percent of possible sunshine data. It is possible to calculate the data using the latitude of the climatological station and the percent of possible sunshine data from a nearby recording station with reliable confidence.

With all of the input data collected, it was possible to calculate the crop consumptive use for each crop within the node basin as well as a weighted crop consumptive use.

Reclamation, in the late 1970's, added a subroutine to the Jensen-Haise program which allowed for the calculation of the crop irrigation requirement (CIR). This subroutine took into account several key factors in the development of the CIR. It analyzed monthly precipitation and, using Reclamation guidelines, calculated a monthly effective precipitation; it uses an available soil moisture holding capacity and average root depth of the crops; and it requires an irrigation when available soil moisture nears 50 percent depletion or at wilt/stress stage.

The program was written with a fixed available water content for the end of each month of the irrigation season. These end-of-month values are April - 100 percent, May - 95 percent, June - 90 percent, and July through October - 80 percent. This criteria limits the amount, either precipitation or irrigation, which the soil will hold during each irrigation month. This provides the crop with a sufficient supply of water to optimize production. There are instances, especially during April and May, when the effective precipitation, when added to

the available soil moisture value, exceeds the water holding capacity of the soil and runoff or deep percolation occurs. The program retains the remaining soil moisture present at the end of the irrigation season and uses it, plus the effective precipitation throughout the winter, to begin the next year's irrigation season. Generally, there is sufficient moisture throughout the winter to refill the profile to a full state, and irrigation requirements are not realized until later in the summer.

Conveyance and On-Farm Efficiencies

Conveyance and on-farm efficiency data has not been well documented in the Upper Missouri Basin area. Reclamation has made contact with various State natural resources agencies and in particular the SCS in hopes that reliable figures could be obtained. The SCS published a Water Conservation and Salvage Report which provides estimates of efficiencies and the SCS themselves cite this document as only an estimate.

Reclamation used the SCS Water Conservation and Salvage Report data provided in the MBSA Hydrology Study to determine appropriate conveyance and on-farm efficiencies. The following efficiencies were used for most node basins.

Furrow Gravity Surface System
- Conveyance Efficiency - 50%
- On-Farm Efficiency - 40%

partial service

Center Pivot Surface Sprinkler – fed by ditch
- Conveyance Efficiency - 50%
- On-Farm Efficiency - 65%

Other Sprinkler Surface Sprinkler
- Conveyance Efficiency - 50%
- On-Farm Efficiency - 65%

Center Pivot Ground Sprinkler — pipeline
- Conveyance Efficiency - 95%
- On-Farm Efficiency - 65%

Other Sprinkler Ground Sprinkler
- Conveyance Efficiency - 95%
- On-Farm Efficiency - 65%

A feature built into the CONUSE3 program allows for the automatic adjustment in efficiencies during a dry period. The program calculates the annual CIR and an average annual CIR throughout the period of record. The average annual CIR is then multiplied by 120 percent to arrive at an adjusted CIR value. The 120 percent is an input value and was determined through evaluation as an acceptable value. The adjusted CIR number is then compared to each year annual CIR value. If the annual CIR value is greater than the adjusted CIR value, then a dry year is projected and an adjustment in the efficiencies is made and the diversion requirements are recalculated. The rationale to perform this operation is

merited based upon the assumption that the irrigators will be more efficient during a dry period and the amount of water diverted would have to adjusted.

During the development of a natural flow data base, it became apparent that for some basins, the efficiencies used were not acceptable. Because the efficiencies were only estimates, Reclamation felt the error associated with the estimates was plus or minus 10 percent. Thus, the efficiency was increased up to 10 percent for several basins to achieve realistic natural flow values.

Return Flow Delay Patterns

The MTDNRC performed a somewhat detailed analysis of the return flow for each node basin by collecting data used to calculate Gloverian factors for use in Glover's method of predicting return flows. The MTDNRC used a systematic method to obtain the basic information and document the measurements and estimates used to make final estimates of a Gloverian factor for each node basin.

The following is a summary of MTDNRC's methodology:

* Base maps were prepared using land classification maps.

* The lands within each node basin were classified as either unfarmed highlands, sparsely drained lowlands or densely drained lowlands.

* The node basins were divided into subareas which were generally smaller than the tributary basins of similar geomorphic characteristics.

* Areas of each land category were measured with a planimeter, and lengths of tributaries suspected to act as drains were measured.

* Drain spacing was calculated by dividing each categorized area by the length of draining tributaries within or adjacent to the area.

* Estimates of transmissivity were made by using specific capacity information from State well logs.

* Storativity was assumed to be .22 for densely drained areas, .12 for tertiary upland deposits, and .17 for subareas in which both types of deposits were present, but were not densely drained.

* Gloverian factors were calculated for each land category in each subarea.

* Gloverian factors for each land category in each subarea were multiplied by the percent of irrigated land in the node basin to provide a weighted average value for each node basin.

The MTDNRC indicated that using a single value to reflect the return flow characteristics for extremely large areas in which basin data is scarce leaves room for many uncertainties. However, the final values are largely the result of the dominant values generated from intensely irrigated, densely drained floodplain areas of relatively large extent and having high

transmissivity values. Thus the overall area error is largely restricted to data obtained for these particular areas.

Reclamation used the return flow patterns developed by the MTDNRC in most cases. However, in some node basins, the Gloverian factor was modified so realistic natural flow values could be determined. Reclamation chose to modify these factors because of the subjectivity used in their determination.

The return flow delay patterns mentioned above are applied to that portion of agricultural losses, either from on-farm or conveyance system loss, which enter into the subsurface. Reclamation assumed 60 percent of any water lost and not non-beneficially, consumptively used returns to the stream during the same month it was diverted via surface water returns. Surface water returns originate from sources such as field runoff, agricultural drains, and canal wasteways. The remaining 40 percent of the loss is assumed to percolate into the ground and return to the stream via the subsurface. Reclamation assumed that 25% of the water which was lost did not return to the system and was non-beneficially consumptively used.

Municipal and Industrial Use

Municipal depletions were calculated for three large communities in the Upper Missouri River Basin: Great Falls, Bozeman, and Helena. Population figures were taken from U.S. Census Reports for the period 1930 through 1980. Population projections through 1987 were made available from the respective communities. Estimates of per capita day usage of water for each community were taken from MBSA reports and from an unpublished Reclamation document. Average annual withdrawals were calculated using the population figures and the per capita usage figures.

Several assumptions, regarding return flow and depletion rates, were taken from the MBSA study. They include: all the return flow were returned within the same month of diversion, and the depletion rate would be 45 percent of the diversion.

After the depletions were calculated on an annual basis, a monthly distribution was determined, again using information from the MBSA report. The values used are:

Jan - .03	May - .10	Sep - .11
Feb - .03	Jun - .13	Oct - .08
Mar - .06	Jul - .18	Nov - .03
Apr - .07	Aug - .15	Dec - .03

Calculation of Depletions

At any given node basin there may be a variety of depletions occurring from agricultural, municipal and/or industrial use. Depletions can be either positive or negative. For example, agricultural depletions are generally positive during the irrigation season. However, after the irrigation season, during the fall and winter, agricultural depletions are generally negative due to return flows coming back to the stream. A negative depletion means more water is entering the stream reach than is being removed.

A depletion is calculated by summing all of the diversions, agricultural, municipal or industrial, in a node basin during a given month and then subtracting any returns to the node basin during the same month. Returns to a node basin during a given month can originate during that month or any of the previous 11 months.

An agricultural diversion value is calculated by multiplying the acreage by the crop irrigation requirement then dividing by both the on-farm and conveyance system efficiencies. There is a possibility of 8 different types of agricultural diversion for each node basin depending upon the type of irrigation and whether a full or partial supply is delivered.

A municipal diversion is calculated by multiplying a population by the estimated water use per person per month. The depletion rate was assumed to be 45 percent of the diversion requirement.

Calculation of Naturalized Flows

The U.S. Geological Survey (GS) is recognized as the responsible Federal agency for obtaining field data and for manipulating certain data sets to meet specified needs. Because most of the sites where naturalized flows are required are GS streamflow gaging sites or at reservoir locations, and because the GS has developed long-term extended flow records for many sites in the basin, Reclamation requested the GS to develop the naturalized flow record. A naturalized flow set was required for each node basin for the entire period of record.

The human-caused flow depletions for each node basin were provided to the GS by Reclamation. Records of monthly changes in storage and surface area were furnished by Reclamation for all reservoirs where Reclamation maintains such records. All other reservoir data was obtained by the GS from appropriate Federal and State agencies.

At all node basins with reservoirs, the historical monthly flows were adjusted algebraically by adding the recorded changes in storage and the net differences in estimated monthly precipitation and evaporation. Monthly depletions were then algebraically added to the adjusted monthly flows to produce estimates of monthly natural flows. At all other gaged sites, the estimates of monthly natural flows were computed by algebraically adding the monthly human-caused depletions.

To obtain extended records of natural flow for the period of record at all sites, a record extension program was used. The program uses a mixed-station approach for extending monthly flow records in which any of several long-term base stations can be used to fill in missing months of data. The record extension program was used only after all historical flows had been adjusted to natural flows and was used only to extend natural flows.

For ungaged sites, natural flows were estimated from regression equations or the application of a drainage area adjustment to upstream or downstream flows.

A total of 15 reservoirs were considered in this analysis and are listed below:

Canyon Ferry	Swift
Clark Canyon	Ruby
Gibson	Madison
Tiber	Holter
Lower Two Medicine	Hauser
Hebgen	Black Eagle
Willow Creek	Lima
Willow Creek near Harrison	

Hydross Model and Canyon Ferry Operations Model

Reclamation's Hydrologic River Operations Study (HYDROSS) model was chosen as the model to use in this analysis. HYDROSS is a surface water supply model developed to assist in planning studies for evaluating existing and proposed demands on a river system. It is intended to operate over a period of record, simulating the effect of existing and proposed features on the historic naturalized flow.

HYDROSS is a system of computer programs for use in conducting monthly water supply studies and can be thought of as a hydrologic accounting model. HYDROSS is a very powerful water supply analysis tool because it allows the user the flexibility to conduct "what if" studies with ease.

Basic input to HYDROSS consists of three data files; flow data, table data and network data. Conceptually, the flow file contains the naturalized monthly flow data at river stations to be modeled. The table file is a means of introducing operational parameters to the model. The network file furnishes HYDROSS with a physical description of the study area; how stations connect, physical facilities and demand locations.

HYDROSS operates on the data in a strict sequential order in time (results from one month depend on the system state at the end of the previous month), space (results at one station depend upon what is happening upstream and/or downstream), and priority (earlier priority dates are allowed water before later priority dates).

HYDROSS offers a relatively strong reservoir operating procedure. However, HYDROSS does not allow streamflow forecasting in its reservoir operating routine. Because Canyon Ferry Reservoir serves as a re-regulation point in the basin, Reclamation felt Canyon Ferry Reservoir needed to be operated with the capability of using streamflow forecasts. The Canyon Ferry Reservoir Operations Model, used by Reclamation to assist in the actual operations of Canyon Ferry Reservoir, was linked to HYDROSS so HYDROSS could more realistically model Canyon Ferry Reservoir.

Output from HYDROSS is available in a variety of formats and can be easily customized to suit almost any need. A small sample of the types of output available from HYDROSS is enclosed.

ATTACHMENT 2

DEPARTMENT OF NATURAL RESOURCES
AND CONSERVATION

MARC RACICOT, GOVERNOR

LEE METCALF BUILDING
1520 EAST SIXTH AVENUE

STATE OF MONTANA

DIRECTOR'S OFFICE (406) 444-6699
TELEFAX NUMBER (406) 444-6721

PO BOX 202301
HELENA, MONTANA 59620-2301

MEMORANDUM

TO: BLM NEGOTIATING TEAM
RESERVED WATER RIGHTS COMPACT COMMISSION

FM: DNRC/RWRCC WORKING GROUP

RICH MOY RM
LAURENCE SIROKY LS
JACK STULTS JAS
LARRY DOLAN LD
KIRK WAREN KEW
STEVE SCHMITZ SS

BILL GREIMAN BG
DAVE AMMAN DA
CRAIG BACINO CB
FAYE BERGAN FB

APPROVED: MARK SIMONICH, DIRECTOR Mark A. Simonich
GARY FRITZ, WATER RESOURCES ADMIN. Gary Fritz

DT: June 10, 1994

RE: Initial Report on Future Development in the Upper Missouri River Basin

The Compact Commission requested input from the Department of Natural Resources and Conservation (DNRC) on current negotiations with the Bureau of Land Management (BLM) regarding their reserved water right claims for the Wild & Scenic stretch of the Missouri River. A Working Group was formed with the DNRC to gather information and explore ideas on how to define the nature and scope of future development in the upper Missouri River Basin.

BLM's concerns have focused on impacts to flows from future consumptive use development and future storage. The Working Group looked at these issues as well as questions regarding administration.

The basic objective of the State is to provide management flexibility for future growth. BLM is open to subordinating their claimed right to future depletions, however, the level of future depletions must be supported by the State and impacts to flows analyzed.

All information contained in this report has supporting documentation available at the RWRCC office.

Consumptive Use Development

Larry Dolan has reviewed irrigable acreage for new development in the Missouri River basin. Fortunately, extensive review of potential irrigation development was recently done for the Missouri River reservation process. (Final Order, June 30, 1992.) The DNRC worked very closely with the area Conservation Districts in preparing applications for water reservations that included most of the potentially feasible irrigation projects in each District. Larry has summarized the information.

IRRIGABLE ACREAGE IN THE MISSOURI RIVER BASIN ABOVE THE FRED ROBINSON BRIDGE.

Granted by the Board in Upper Missouri River basin water reservation proceeding	33,865 acres
Applied for by the Conservation Districts during the upper Missouri basin water reservation proceeding	126,342 acres
Projects determined to be economically feasible in the EIS done for the upper Missouri basin proceeding	98,826 acres

(Memo dated May 12, 1994.)

Therefore, 98,826 acres applied for were economically feasible on their own merit (the direct benefits exceeded the direct costs). Of those acres, water reservations were granted for 33,865 acres to be developed by the year 2020. The remaining 64,961 acres were not granted reservations because total costs - with the indirect costs, including existing hydropower and recreation values - outweighed total benefits.

The acreage for the BOR's Virgelle project is not included in these figures. The Virgelle project calls for 53,600 acres of new and supplemental irrigation in the Milk River basin with a flow rate of 230 cfs. During the reservation process, the BOR stated that depletions from the Missouri River that conflicted with BLM's claims for the Wild & Scenic would be augmented by flows from Tiber Reservoir.

Bill Greiman worked with the Conservation Districts in putting together the original applications for water reservations in the Upper Missouri River basin. He stated that a thorough review of irrigable acreage was done at that time and that most of the potentially feasible projects of significant size were included in the applications.

The Working Group is currently studying future water use for municipal and industrial purposes. The Commerce Department will provide population projections. It is not anticipated that these uses will require significant amounts of water (consumed).

Currently, the Madison, Jefferson, and Teton drainages are permanently closed to new appropriations. The entire upper Missouri River above Morony Dam is temporarily closed to new appropriations until the adjudication process is completed. However, these closures do not prohibit the development of new storage facilities. Instream flow reservations may also be modified to allow for feasible new storage facilities if the resource values are maintained or enhanced by the storage facility.

Storage

Some initial model runs have been done to show the effects of additional storage on BLM's claimed reserved water right. The results indicate that new large storage projects may have some impacts but small storage projects would have no impact and cannot even be reliably modelled. BLM's concern with small storage appears to be how we define what "small" storage is and how cumulative effects would be measured.

Laurence Siroky stated that 12,500 acre/feet is the maximum size for the SCS's engineering standards under its P.L. 566 program for cost-sharing. This size limit is for active storage and for multiple-use projects. Design standards for larger reservoirs would fall under the BOR's or Corps' programs.

The Working Group has not yet analyzed how cumulative effects of small storage, since BLM has not specifically stated their concerns.

Administration

The Working Group has discussed several issues dealing with administration of BLM's reserved water right. However, until BLM has reviewed the impacts of future development on the Wild & Scenic stretch of the Missouri River and stated its position, it is premature to address these issues.

Other issues such as groundwater may arise during the negotiations. The Working Group will address those issues as necessary.

Conclusion

There is substantial support for the State to pursue negotiations for a volume of water to provide for 98,826 acres of potential irrigation development (mostly full service). These acres have undergone extensive economic analysis and are economically feasible to develop on their own merit. These acres also represent the majority of sizable potential irrigation projects in the upper Missouri River basin and the Conservation Districts have demonstrated their interest in developing them. Since irrigation is the most consumptive of potential new development, this use should be the benchmark for identifying a negotiated volume of water for future development. Other uses of water, such as

municipal or industrial, could be accommodated from the water identified by potential irrigation or a small volume could be added to provide for other purposes.

If the negotiations include discussions of storage, the use of federal engineering design standards to define "small" storage makes sense and would provide that most local potential storage projects would fall under the definition of "small."

ATTACHMENT 3

JOINT TECHNICAL WORKING GROUP:

MONTANA DEPARTMENT OF NATURAL RESOURCES
AND CONSERVATION/
RESERVED WATER RIGHTS COMPACT COMMISSION/
BUREAU OF LAND MANAGEMENT

1996

TECHNICAL ADDENDUM TO MONTANA AND FEDERAL NEGOTIATING TEAMS

INTRODUCTION

A working group was assembled to address technical issues related to BLM reserved water rights for the Wild and Scenic Missouri River. The working group is composed of technical personnel from the Bureau of Land Management (BLM), Bureau of Reclamation (BOR), and Montana DNRC. The group was directed to find technical solutions to outstanding issues while working within assumptions compatible with the BOR Upper Missouri River HYDROSS Model. This report details recommendations from the working group. All information contained in this report is subject to the negotiations process and negotiating team approval.

I. MONTHLY FUTURE USE AMOUNTS

Through negotiation, the BLM and State have agreed that future depletions to surface flow (post-1987) will be accounted for on a monthly basis and subtracted from the negotiated water volumes listed in the table below. These volumes include the amounts reserved through the Upper Missouri reservation process (see table). The technical working group has agreed on water volumes for future depletions, which will be subject to negotiating team approval. The volumes currently under consideration are:

Month	Acre-feet
January	104,158
February	120,512
March	124,168
April	201,710
May	236,645
June	79,086
July	88,878
August	79,565
September	39,679
October	35,318
November	56,774
December	98,081

II. CALCULATION OF MONTHLY DEPLETIONS

Depletions to surface flows will be estimated from monthly depletion coefficients developed for various types of water use. In order to monitor the cap amounts, the DNRC will calculate preliminary monthly depletions according to the type of use and subtract the amounts from the future available water. However, permanent subtractions to the cap will be finalized when a permit is perfected and verified.

In order to avoid the uncertainties of developing return flow coefficients on a basinwide scale, the group has focused on the consumptive use amounts required for each type of use, rather than trying to calculate the difference between diversion amounts, direct return flows and delayed return flows in the variety of circumstances that can occur throughout the basin. Therefore, the group has assumed that depletions will occur in the same month as the diversions.

The DNRC will use the definition in Section 85-2-342(3) MCA to determine whether a particular use is non-consumptive. In addition, groundwater uses of less than 35 gallons per minute, up to 10 acre feet per year, and surface water permits of less than 35 gallons per minute and 10 acre feet per year for domestic use will not be counted against the cap.

Following is a list of the use codes now employed by DNRC, and the recommended monthly depletion coefficients.

Category 1.
Fishery, Wildlife, Recreational and Wildlife/Waterfowl Uses:
FS Fishery
FW Fish and Wildlife
RC Recreation
WW Wildlife Waterfowl

Since the water loss resulting from these uses occurs as evaporation from small ponds, depletions from the above uses will be calculated using lake evaporation factors. The monthly evaporation factors are the same as those used in the BOR model to estimate net evaporative losses at Canyon Ferry Lake, which is located at approximately mid-basin. The losses were averaged over the period of record, 1929 through 1987. The following table lists the monthly evaporative loss in feet:

January	0.00
February	0.00
March	0.00
April	0.08
May	0.17

June	0.26
July	0.50
August	0.51
September	0.35
October	0.26
November	0.04
December	0.00

Depletions will be calculated by multiplying the above factors by reservoir surface area (acres), determined upon completion and verification of the project. Depletion amounts will be subtracted from the monthly caps.

Category 2.

Geothermal and Power Generation Uses:

GE Geothermal
PG Power Generation

The consumptive portion of geothermal and power generation uses will be determined by DNRC on a case-by-case basis, and subtracted from the monthly caps.

Category 3.

Domestic, Multiple Domestic and Municipal Uses:

DM Domestic
MC Municipal
MD Multiple Domestic

The BOR Upper Missouri Basin model used a depletion of 45% of the diversion for municipal uses, distributed monthly as follows:

		resulting depletion factor
January	3%	(.45 * .03) = .0135
February	3%	= .0135
March	6%	= .0270
April	7%	= .0315
May	10%	= .0450
June	13%	= .0585
July	18%	= .0810
August	15%	= .0675

September	11%	= .0495
October	8%	= .0360
November	3%	= .0135
December	3%	= .0135

Monthly depletions for municipal, multi-family domestic, and non-exempt domestic uses will be calculated by multiplying the issued volume by the monthly depletion factors listed above, and subtracted from the monthly caps.

Category 4.

Irrigation including Lawn and Garden over 5 acres:

IR Irrigation

LG Lawn and Garden

To derive irrigation depletion coefficients, the working group agreed to use crop consumptive use requirements calculated from Great Falls weather station data. The following are net irrigation requirements (inches) for alfalfa during the 80% exceedence year. Depletion factors will be multiplied by the number of permitted acres to determine depletions, in acre feet. Monthly depletions will be subtracted from the monthly caps.

	net irrigation requirement (inches)	depletion factor (feet per acre)
January		0.0
February		0.0
March		0.0
April		0.0
May	2.50	0.2604
June	4.47	0.4656
July	7.12	0.7417
August	5.65	0.5885
September	1.13	0.1177
October		0.0
November		0.0
December		0.0

LG Lawn and Garden: for greater than 5 acres, depletions follow those used for irrigation; permits for less than 5 acres are exempted from this process.

Supplemental irrigation water rights involve multiple water sources or points of diversion

used to irrigate the same acreage. While each water right may reflect the amount necessary to irrigate the acreage, generally only one or part of each right is actually used at any given time. The concern has been raised that subtracting supplemental water rights from the cap will result in overestimating actual consumption. In the future, supplemental water rights will be identified by the DNRC from the application, but will not be subtracted from the monthly caps.

Category 5.
Livestock Uses:
ST Stock: for stock ponds, depletions will be calculated using the monthly lake evaporation factors and subtracted from the monthly caps. Other stock uses will not be counted against the cap.

Category 6.
Commercial, Industrial, Institutional, Mining and Other Uses:
OP Other Purpose
CM Commercial
IN Industrial
IS Institutional
MN Mining

A methodology to account for depletions occurring from these uses will be discussed at the negotiating session.

III. GROUNDWATER

Groundwater uses of 35 gallons per minute or less up to 10 acre feet will not be counted against the cap. The Joint Technical Team and the Negotiating Teams have not agreed on a methodology to account for groundwater uses of greater than 35 gallons per minute and more than 10 acre feet per year. The accounting for groundwater uses will be discussed at a negotiating session.

IV. STORAGE

Future storage projects will be assigned depletions based on the lake evaporation table, in addition to the depletion coefficients developed for the specific use for which the water is stored. For example, if water is stored for irrigation use, depletions will be calculated based on both evaporative losses for the entire storage period and the crop consumptive factors listed above. The depletions will be subtracted from the month during which the

water is stored. A methodology to account for when storage depletions will be subtracted from monthly caps will be discussed at a negotiating session.

V. ADMINISTRATION

DNRC will administer the future water use cap by subtracting depletions from the monthly available water amounts, and producing an annual report by March 1st of each year describing permit activity and status of the cap.

A cooperative review process will be created allowing the BLM and DNRC to discuss depletion coefficients and depletion amounts assigned to the undefined uses (commercial, industrial, institutional and "other purposes"). BLM suggests that a Memorandum of Understanding and annual meeting to discuss the annual report might be the best means to accomplish this. This issue will be discussed at a negotiating session.

The working group recommends that late claims as defined by MCA 85-2-221 should not count against the cap, because those uses are reflected in the HYDROSS model to the extent that they have been used historically. Conversely, since abandoned claims are not reflected in the model, any application to reallocate the water associated with these claims should be subtracted from the cap.

Future appropriations of groundwater will be counted against the development cap **only** if they do not qualify for exception from permit requirements under Montana law (See MCA 85-2-306: Exceptions to Permit Requirements). This exception allows the appropriation of water from a well or developed spring with a maximum appropriation of 35 gallons per minute or less, not to exceed 10 acre-feet per year without a permit. Combined appropriations from the same source from two or more wells or developed springs which exceed the 35 gallons per minute / 10 acre-feet per year limitation **do** require a permit under MCA 85-2-306 and would therefore be counted against the cap.

All groundwater applications which require a permit will be counted against the development cap, regardless of location or source aquifer. The depletion coefficient applied to groundwater applications will be determined by the purpose of use to which the water will be put (i.e. irrigation use depletion coefficients will be determined by the season of use for irrigation and the coefficients developed for irrigation). Once the total depletion amount has been calculated, the depletions will be spread in equal increments throughout the year (1/12th of the total volume subtracted from each monthly cap amount).

Storage Addendum to Joint Technical Working Group Report 7/9/96

Future storage projects will be assigned depletions based on the combined lake evaporation data and depletion coefficients for the specific purpose for which the water is stored. Two basic approaches will be followed depending on the volume of reservoir water available and the volume of water needed to satisfy the purposes.

SCENARIO 1: Reservoir Volume Greater Than Demand

Under this scenario, depletions to the cap will be calculated based on the sum of reservoir evaporation and the depletions calculated by the purpose coefficients listed in the Joint Technical Team Report. Upon determining the total depletion, the monthly depletion distribution will follow the typical fill regimen for reservoirs in this area. The following schedule is based upon historical data for six existing reservoirs (Middle Creek, Smith River, Swift, Martinsdale, Willow Creek and Ruby Reservoirs,see attachment 1). This data shows a normal fill regimen from November through June at the following rates:

Month	% of Volume added
November	7%
December	7%
January	8%
February	7%
March	10%
April	21%
May	38%
June	2%
Total	100%

This fill schedule will be applied to all future reservoirs unless the application for permit specifies a different fill regimen.

The annual evaporation amount will be calculated based on the lake evaporation schedule proposed in section II of the joint technical group report. The crop depletion amounts will be totalled based on the number of acres served by the reservoir and the use months allowed by the permit (i.e. if the permit authorizes a period of use that includes July and August, the crop depletion factors for July and August will be used to calculate the crop depletion portion of the use amount to be subtracted from the cap). The total of these two amounts, annual evaporation plus crop depletions, would equal the total depletion amount for the reservoir. This amount would then be subtracted from the cap for the months during which the reservoir would fill. Since the reservoir would likely be filled over a period of several months, the amount to be subtracted from the cap for each fill month would be based upon the fill schedule shown above.

The example below illustrates the depletion calculations for a hypothetical reservoir.

Example 1: Storage Reservoir For Irrigation Use.

In the situation where an offstream storage reservoir is developed to supply water for irrigation use, the depletion would be calculated as follows:

A 1500 acre foot reservoir with 150 surface acres is proposed for off stream storage of water for irrigation use. The requested season of use is June through September to irrigate 500 acres. The following calculation shows the depletions that would apply to the cap.

Crop depletion amounts:

Month	Depl Factor AcFt/Acre	Total Crop Depl. Ac.Ft.
June	.4656	232.80
July	.7417	370.85
August	.5885	294.25
September	.1177	58.85
Total Irrigation Use		**956.75**

Lake evaporation amounts:

Month	Evap depl factor feet/surface acre	Evaporation total acre-feet
January	0.00	0.00
February	0.00	0.00
March	0.00	0.00
April	0.08	12.00
May	0.17	25.50
June	0.26	39.00
July	0.50	75.00
August	0.51	76.50
September	0.35	52.50
October	0.26	39.00
November	0.04	6.00
December	0.00	0.00
Total evaporation loss		**325.50**

Total Consumptive use for reservoir = 1282.25

Depletion amounts to be subtracted from cap for this reservoir:

Month	% Fill	Amount subtr from cap (1282.25 * %fill)
November	7	71.21
December	8	81.38
January	7	71.21
February	7	71.21
March	10	101.72
April	21	213.62
May	38	386.56
June	2	20.34
Total		**1282.25**

SCENARIO 2: Demand Exceeds Reservoir Volume

In the case where demand exceeds supply of the reservoir, the remaining demand over and above reservoir supply will be depleted in the same manner as any direct flow water right, provided that it isn't a supplemental right.

Example 2:

A 1500 acre foot reservoir with 150 surface acres is built to supply water for 2000 acres of irrigated land. The period of use is June through September. The following example illustrates the calculation of the depletions which would be deducted from the future use cap.

Calculation of Demand

Crop depletion amounts:

Month	Depl Factor AcFt/Acre	Total Crop Depl. Ac.Ft.
June	.4656	931.20
July	.7417	1483.40
August	.5885	1177.00
September	.1177	235.40
Total Irrigation Use		**3827.00**

Lake evaporation amounts:

Month	Evap depl factor feet/surface acre	Evaporation total acre-feet
January	0.00	0.00
February	0.00	0.00
March	0.00	0.00
April	0.08	12.00
May	0.17	25.50
June	0.26	39.00
July	0.50	75.00
August	0.51	76.50
September	0.35	52.50
October	0.26	39.00
November	0.04	6.00
December	0.00	0.00
Total evaporation loss		**325.50**

Total Consumptive use = 4152.5 acre feet

Since the usable volume in the reservoir equals reservoir volume minus evaporative losses, the volume that can be supplied by the reservoir is (1500 - 325.5) **1174.5 acre feet**. This means that the remaining demand of (4152.5 - 1500) **2652.5 acre feet** must be supplied from natural flow.

Depletion amounts to be subtracted from cap for this reservoir:

Month	% Fill	Amount subtr from cap (1174.5 * %fill)
November	7	82.22
December	8	93.96
January	7	82.22
February	7	82.22
March	10	117.45
April	21	246.64
May	38	446.30
June	2	23.49
Total		**1174.50**

Depletion amounts to be subtracted from cap, due to natural flow use:

The remaining demand of 2652.5 acre feet will be supplied by natural flow and depletions will be distributed monthly. This water volume will irrigate 1386.2 acres, and depletions would be based on crop consumptive use coefficients as follows:

Month	Depl Factor AcFt/Acre	Total Crop Depl. Ac.Ft.
June	.4656	645.42
July	.7417	1028.15
August	.5885	815.78
September	.1177	163.16
Total Natural Flow Use		**2652.51**

Summary of Monthly Depletions to Cap:

Month	Total Depletion (AcFt)
January	82.22
February	82.22
March	117.45
April	258.65
May	471.81
June	707.91
July	1103.15
August	892.28
September	215.66
October	39.00
November	88.22

December	93.96
Total	**4152.53**